

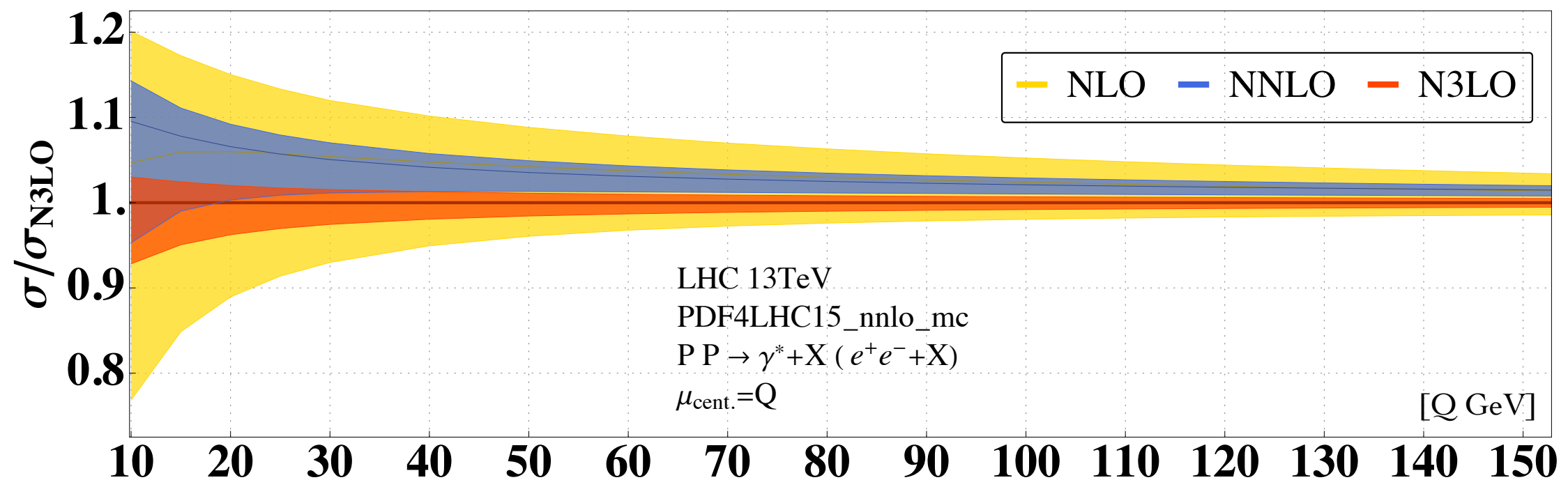


# The push to the N<sup>3</sup>LO frontier

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Snowmass Theory Frontier  
Town Hall Meeting  
30 July 2020

- Inclusive LHC cross sections known at N3LO:  $ggH$ ,  $bbH$ ,  $\gamma^*$ ,  $W$ ,  $ggHH$  [Chen, Li, Shao, Wang], VBF-DIS [Dreyer, Karlberg].
  - ➔ Simpler than differential/multi-scale processes.
  - ➔ Use them as templates to understand the precision we can reach.
- General pattern:  $K_{\text{QCD}}^{\text{N}^3\text{LO}} = \frac{\text{N}^3\text{LO}}{\text{NNLO}} \sim 0.95 - 1.05$  [except VBF-DIS]
  - ➔ Residual scale dependence  $\sim \text{few } \%$
  - ➔ PDF  $+\alpha_s$  uncertainty  $\sim 2 - 9\%$
  - ➔ Uncertainty from missing N3LO PDFs  $\sim 1 - 3\%$



- Target precision:  $\sim 1\%$ 
  1. N3LO K-factor  $\sim$  few % even for simplest processes!
  2. We need to improve on PDFs (incl. N3LO-PDFs!).
  3. Non-overlapping scale bands: need better way to estimate uncertainty from higher orders.
- ➔ Related to large cancellations between partonic channels?
- ➔ Present for DY and W, not for H.
- ➔ Intricate interplay between missing higher order and PDF uncertainty?

